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Feature Article - Trend estimates and unusual real events in ABS Statistics

INTRODUCTION

Time series of economic statistics are often affected by the occurrence of unusual events. In recent years, examples of major unusual events have included the Sydney Olympics (October 2000) and the introduction of the New Tax System (June 2000). This article (**see endnote 1**) illustrates how unusual real events can impact on Australian Bureau Statistics (ABS) time series, in particular, the trend estimates. It also provides information on how unusual events are treated in the seasonal adjustment process.

SEASONAL ADJUSTMENT PROCESS

Seasonal adjustment is an analytical tool that estimates and removes the effects of normal seasonal influences from time series. Seasonal influences (including all systematic calendar effects) tend to occur regularly once or more per year. They include the effect of periodic factors such as weather, holidays, social conventions, administrative practices, and the composition of the months or quarters in terms of trading days. Typically, the ABS decomposes an original time series into trend, seasonal and irregular components. Seasonally adjusted estimates are produced by estimating the seasonal component and removing this component from the original series. The seasonally adjusted estimates reflect the combined effect of the irregular, i.e. short term variations, and the trend (defined as the remains from removing the irregulars from the seasonally adjusted estimates), i.e. the underlying direction of the series. The trend represents the fundamental direction of the series and captures the longer-term direction of the series as well as the inherent business cycles. Trend estimates are calculated by applying a smoothing procedure to the seasonally adjusted estimates. The details of ABS trend estimates method can be found in '**A Guide to Interpreting Time Series - Monitoring Trend**' (ABS, 2003, cat. 1349.0).

WHAT ARE UNUSUAL EVENTS ?

Unusual events can be grouped into two categories according to their causes:-methodological changes and real world effects.

Methodological changes

The introduction of changes to the methodology of a collection will often cause an impact on the statistical estimates. These changes may include improvements to the scope, coverage, definitions, survey forms, sample design and estimation techniques, or any other change in the way the ABS collects the data. Examples of methodological changes affecting ABS time series include the introduction of an adjustment for new business provisions in the Retail Trade series,

data reclassifications in business surveys, use of data available from the new taxation system in some economic surveys and the introduction of a redesigned questionnaire in the Labour Force Survey.

Statistical impacts arising from methodological changes could bias the original movement estimates and, if not addressed, could add noise in the measurement of real world changes. The ABS aims to maintain the continuity of important time series over periods when methodological changes are introduced to the collection. When they occur these statistical impacts will be brought to the attention of the users and, where possible, removed from the original series through an adjustment process. The methodology for the adjustment and the impact of the adjustment on the estimates is described in the relevant ABS publications.

In cases where the ABS does not seek to maintain the continuity of a time series, the ABS will usually provide information on the magnitude of the break in the series caused by the methodological change. This is normally done by using estimation techniques, although in some rare cases a parallel run may be used.

Real world effects

Real world effects are unusual events which have a significant impact on ABS statistics. Examples of real world effects include the 1989 airline pilots' strike, which impacted on the Tasmanian passenger arrivals by air series; major construction projects such as the Sydney Olympic stadium in 1996, which affected the Non-residential building approvals series; the gold sell-off by the Reserve Bank of Australia in 1997, which affected the Exports of other goods series; and changes to taxation legislation, such as the introduction of the Goods and Services Tax in July 2000, which affected the Retail Turnover series.

This article will focus mainly on the impact of real world effects. Real world effects can be subdivided into those where the cause can be identified (as in the examples above) and others, which are apparent in the data, but which cannot be explained entirely satisfactorily by known events.

HOW UNUSUAL EVENTS MAY AFFECT THE ABS TIME SERIES

The seasonal adjustment procedure used by the ABS is based on the X11 method developed by the US Bureau of Census (Shiskin et. al, 1967). In this method, any large temporary or permanent change in the original time series will have a statistical impact on the trend estimates. The seasonal factors and seasonally adjusted estimates will also be affected. All of these estimates are affected to different degrees in the seasonal adjustment process:

- For the estimation of **seasonal factors**, the current seasonal adjustment process is relatively robust as it will discount 'extreme' irregular values so that the seasonal factors are not distorted in the short term. For example, for series with low volatility any extreme irregular value larger than 1.5 times the standard deviation (a quantity to measure the spread of the volatility over time) will be neglected, and the seasonal adjustment process will treat the occurrence of the extreme irregular as an outlier, replacing it with a smaller value for the purpose of estimating the seasonal factors.
- **Seasonally adjusted estimates** are derived by dividing the original series by the appropriate seasonal factor. When unusual events occur the seasonally adjusted estimates will include the impact from the event. However, because of the robustness of the seasonal factors, the accuracy of the seasonally adjusted series will not be compromised by the occurrence of the irregular (provided that it is understood that the seasonally adjusted

number includes the effect of the real world event).

- **Trend estimates** are obtained by smoothing the seasonally adjusted estimates. Assuming the irregular is 'normal' noise in the data, the ABS smoothing method (ABS, 2003, cat. 1349.0) removes 'normal' irregulars and produces trend estimates. The impact of extreme one-off unusual events will produce large 'abnormal' irregulars in the seasonally adjusted series. As a consequence the trend estimates from the smoothing method are distorted from the real underlying movement of the series if no correction for the impact is introduced.

To reduce distortion due to the occurrence of unusual events, seasonally adjusted and trend estimates can be improved by applying appropriate prior correction to the original estimates for the unusual events. A prior correction does not change the published original estimate, but would modify the input to the seasonal adjustment process, and removes the impacts of the unusual events from published trend estimates.

A prior correction is derived by estimating the outlier for an unusual event. How to accurately identify and measure an outlier is still the subject of debate between experts in this area. For example, should the outlier be identified from the statistical characteristic of the series alone, or with the exact information from the subject matter area? ABS adopts a cautious approach using statistical methods to identify the outlier, and then uses the exact information to quantify the size of the outlier whenever possible.

If information on an unusual event is available prior to the seasonal analysis, the correction may be implemented at the period of occurrence. In many cases, however, the statistical impact has to be estimated from the time series itself and the correction cannot be implemented until further data become available. In rare occasions, a subjective decision may be needed to determine if a statistically estimated prior correction should be implemented when exact information about the cause is not available.

Unusual events may affect one or more of the three components of time series. For example, it may cause a change in the underlying movement (trend), a change to the pattern of seasonal variations (seasonality), or a short term, one-off impact (irregular). Details of such corrections are discussed below.

Large extreme value (one-off)

A large extreme irregular is an uncharacteristic movement in the original estimates. For example, the Sydney Olympics (September 2000) had a one-off effect on the overseas passenger arrivals series, and retail turnover series. This caused a one-off impact on the seasonally adjusted series. Where a one-off extreme impact is not corrected, it can distort the underlying movement as represented by the trend estimates. If prior information on the magnitude of the impact is available, a correction for the trend for the affected time points would be implemented. However, in this example, such information was not available at the time. At least one or more additional observations are normally required to help assess the one-off effect. The original and seasonally adjusted series will still contain the full impact of the large extreme value.

Trend break (permanent)

A trend break is an abrupt and sustained change in the trend path of a series between one period and another. When trend breaks occur, the ABS will correct for the permanent shift in the trend estimates, by estimating the size of the break and including it in the trend path.

Where prior information is available on the magnitude of a trend break, the size of the trend break can be factored into the trend analysis (see examples on the following page). More commonly, data for estimating the trend break may not be available at the time when the change occurs. In the absence of a reliable estimate of the impact, the ABS has to use the series to estimate, post-hoc, the magnitude of the trend break. Three or more observations after the occurrence of the trend break are needed to reliably estimate the magnitude of the trend break.

The improvement of the trend estimation will also help to improve the accuracy of the seasonal factor estimates. This will result in improved accuracy of the seasonally adjusted series. The original series and the seasonally adjusted series will still contain the full impact of the trend break.

Seasonal break (permanent)

A seasonal break is a permanent break in the seasonal pattern of a time series. Such changes occur when seasonal, trading-day and pay-day patterns change abruptly. For example, the introduction of new legislation may affect the timing of tax collections. Often they cannot be readily identified, as three or more years of data after the seasonal break are needed to accurately assess the nature of changes in seasonal pattern.

Abrupt changes to the seasonal pattern can have adverse effects on the reliability of seasonally adjusted estimates and trend estimates. Such breaks in the seasonal factors are recognised and corrected for, but usually only after at least three years have elapsed. Prior to introducing a seasonal break correction, the seasonally adjusted series and the trend series would be distorted for several years. This usually manifests itself as an episode of increased volatility in the series, until sufficient data accumulates to enable the seasonal factors to be stabilised again. The original series will still contain the full impact of the seasonal break.

HOW ARE UNUSUAL EVENTS TREATED IN THE SEASONAL ADJUSTMENT PROCESS

Different types of corrections are applied in the seasonal adjustment process, according to the nature of the event, its potential impact on the seasonally adjusted estimates and trend estimates, and the availability of information for making a correction. Four typical outcomes can occur:

1. Trend estimates and seasonal factors are allowed to continue their natural course i.e. no correction is made.

The airline pilots strike in late 1989 had a significant impact on the level of the Tasmanian passenger arrivals by air series. Figure 1 shows the seasonally adjusted and trend estimates up to and including December 1989 (when the pilots' strike ended). At the time, there was no information available to indicate how long the strike would persist. Therefore, no correction to the trend estimates was made in any of the five months in which the strike occurred.

The seasonally adjusted time series showed a dramatic fall but was rising again towards the end of 1989. Information available at the time indicated that passenger arrival numbers would return to the previous level. The underlying nature of the time series would therefore be best represented by not intervening in the usual calculation of the trend.

FIGURE 1: TASMANIAN PASSENGER ARRIVAL NUMBERS BY AIR, 1980 TO 1989.

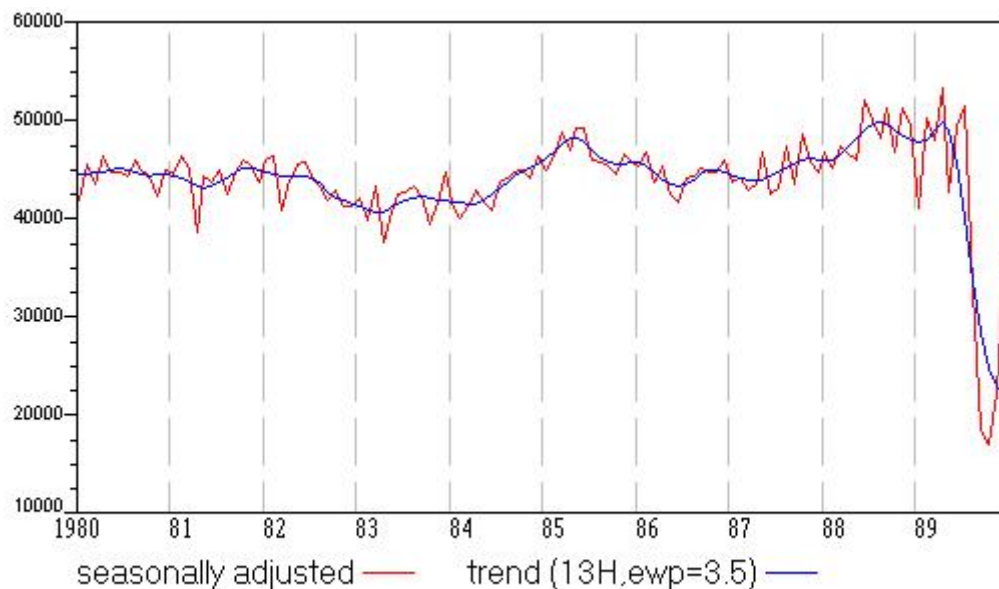
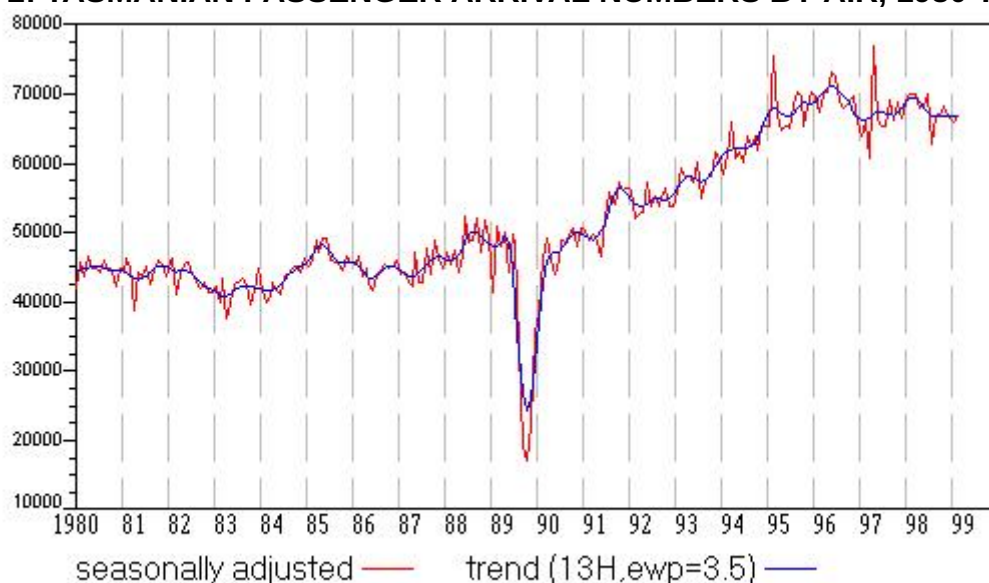


Figure 2 shows the same time series as in Figure 1, up to and including January 1999. Although passenger numbers fell abruptly over two consecutive months (August and September, 1989), they recovered more gradually over the following five months. A decision was made not to make any intervention. Figure 2 shows how, as more data became available during 1990, the trend adapted and now tracks the dip in activity during late 1989 well. A permanent trend break correction would have been misleading (**see endnote 2**).

FIGURE 2: TASMANIAN PASSENGER ARRIVAL NUMBERS BY AIR, 1980 TO 1999.

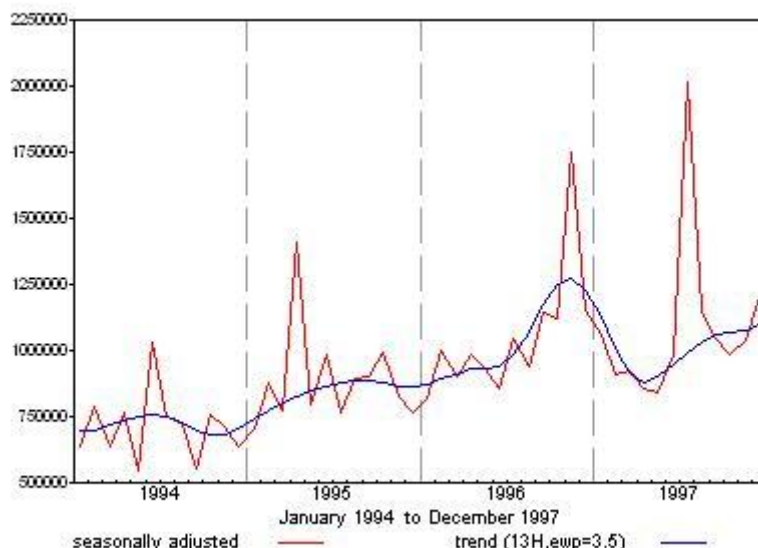


2. A correction is made for the extreme/unusual estimate after one additional original estimate becomes available i.e. no correction is made at the time of occurrence and the trend series may be suspended but a correction is inserted for the next publication.

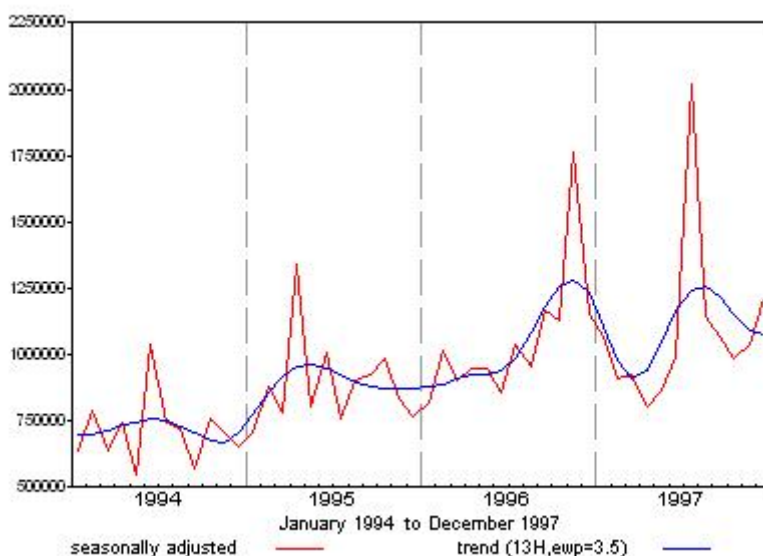
Several large construction projects had a substantial impact on the value of Australian non-residential building approvals as shown in Figure 3. These were caused by the approval of the Melbourne Casino in June 1994, the Sydney Casino in April 1995, the Sydney Olympic Stadium in November 1996 and two new Brisbane hospitals in July 1997. Specific information on the

value of these projects was available from the data collection itself, and was used to correct for the trend estimates in a timely manner. Figure 3 shows the trend series, with those corrections applied. Without this information, the trend estimates would have been distorted for several months around the period of the impact of the unusual event, as shown in Figure 4.

FIGURE 3: VALUE OF AUSTRALIAN NON-RESIDENTIAL BUILDING APPROVALS, 1994 TO 1999.



**FIGURE 4: VALUE OF AUSTRALIAN NON-RESIDENTIAL BUILDING APPROVALS, 1994 TO 1999,
WITHOUT AN EXTREME CORRECTION AT JULY 1997 OR APRIL 1995.**



In the case where there are very large extreme/unusual estimates, but a cause is not known, the seasonal adjustment system used by the ABS can sometimes provide an indication of an appropriate correction. If this occurs at the most recent time point, care needs to be taken to distinguish between a one off event or an emerging underlying change in the trend. If the correction cannot be reliably estimated the following options are considered:

- a. no correction is applied

b. suppression of the trend estimate until a reliable estimate can be obtained.

In all cases the appropriateness of the correction is assessed against known information and by the quality of the seasonal adjustment.

3. A trend break correction may be introduced after three or more periods after the occurrence. The trend estimates may not be published prior to introducing a trend break for correction.

The introduction of The New Tax System (TNTS) in July 2000 had a permanent impact on the Retail Trade series. Prior information on the extent of the impact was not known. For the period June to November 2000 the trend estimates of the Retail Trade series were suspended because the underlying behaviour of the series could not be accurately estimated. The original and seasonally adjusted estimates were still published. The trend series was reintroduced from December 2000 after a correction to the trend estimates was made by using data up to November 2000 to estimate the permanent level shift (trend break) between June and July 2000.

Figure 5 shows the impact of the pre-GST increase in Retail trade on the seasonally adjusted estimate in June 2000. As pre-GST spending is not part of the underlying behaviour of the series, the trend would have been distorted ('Trend before correction') if the normal seasonal adjustment process was allowed to continue. The corrected trend ('Trend after correction') is also shown, where some one-off pre-GST impacts were identified and removed from the trend series.

FIGURE 5: RETAIL TRADE - TREND ESTIMATE BEFORE AND AFTER CORRECTION.

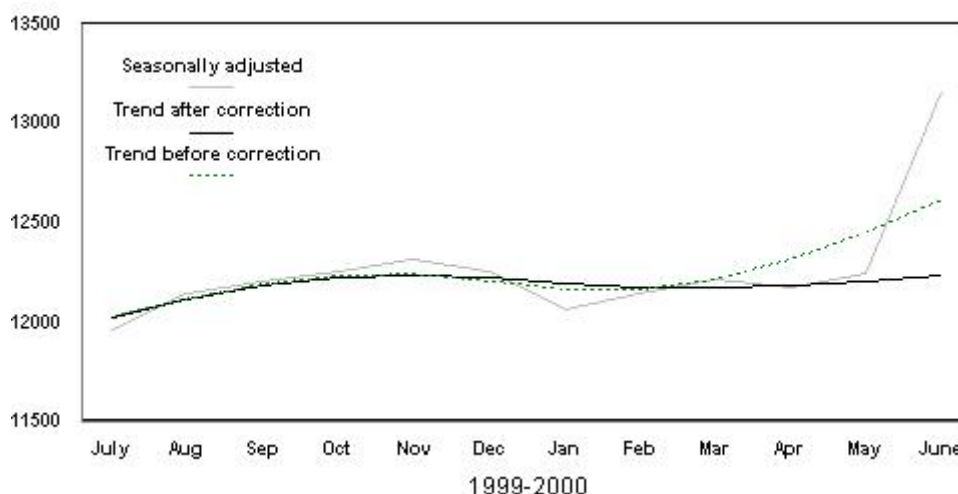
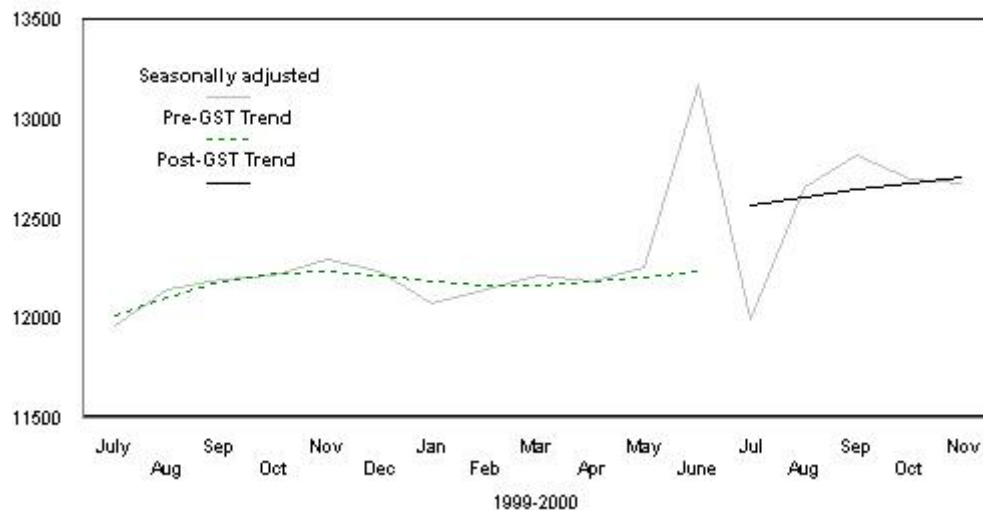


Figure 6 shows the impact of the new tax system on the seasonally adjusted and trend estimates of retail trade series in November 2000. It is important to have two different levels in the retail trade series to distinguish between the pre- and post-GST periods.

FIGURE 6: RETAIL TRADE - THE PRE-GST AND POST-GST TREND.



4. A correction for a break in seasonal factors may be introduced after three or more years of additional original estimates are available. The trend estimates and seasonal adjusted estimates are not revised prior to the correction.

Changes relating to taxation affected the Pay As You Earn (PAYE) income tax refunds series used by National Accounts. These included a change in the rate of processing refund applications for individuals in 1991 and the introduction of self assessment in 1993. These changes impacted on the seasonal pattern of PAYE refund payments as can be seen by close examination of the original data series in Figure 7 below. The seasonal peaks moved from July, August and September prior to 1992 to August and September. Figure 7 shows the corrected seasonal series, after the impact of this change had been estimated and removed. Figure 8 shows that if the breaks in seasonal patterns are not corrected for, the seasonally adjusted estimates would be subject to residual seasonality (note the peaks in July from 1991 to 1993 in the seasonally adjusted series) and increased volatility.

FIGURE 7: P.A.Y.E. REFUNDS, 1985 TO 1995, WITH CORRECTION FOR SEASONAL BREAKS

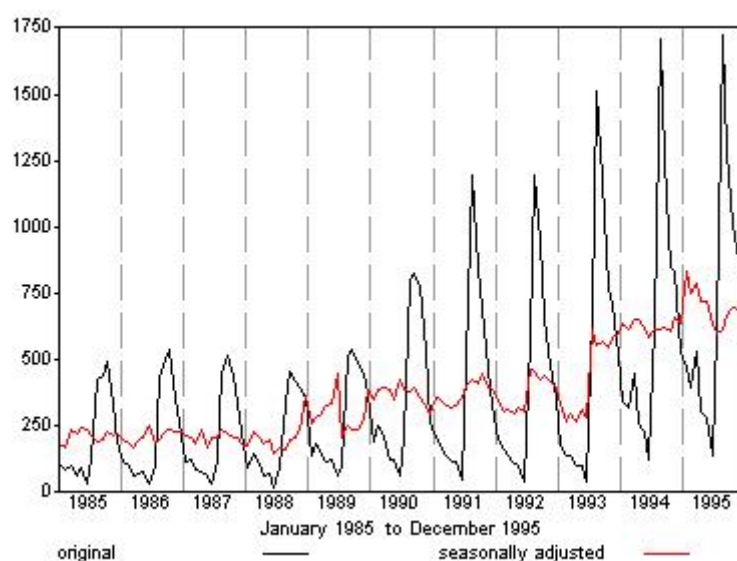
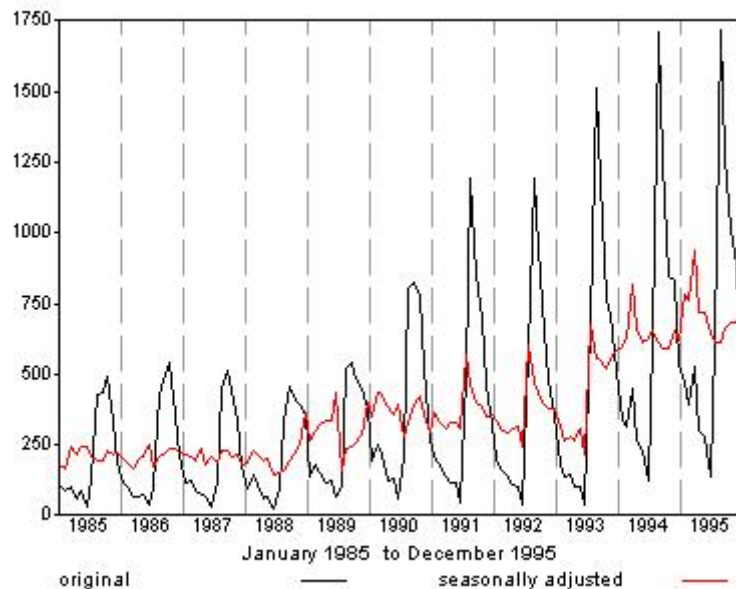


FIGURE 8: P.A.Y.E. REFUNDS, 1985 TO 1995, WITHOUT CORRECTION FOR SEASONAL BREAKS.



CONCLUSION

This paper has illustrated how the occurrence of unusual events can impact on ABS time series seasonally adjusted and trend estimates. The impact can be minimised in a timely manner if reliable prior information exists for estimating the statistical impact of the event. However, such information is usually not available and, typically, the ABS has to estimate the extent of the effect from the data itself. Prior to the correction being introduced for seasonal adjustment, there may be a period during which the seasonally adjusted estimates and trend estimates are subject to some distortion. All the prior corrections introduced are only used to produce better seasonally adjusted and trend estimates. The published original time series estimates are never altered for unusual real world events.

Some fine tuning of the corrections may be necessary even after they have been made. For example, extreme corrections may be refined when additional time periods have elapsed, or there may be a need to fit trend break correction, or seasonal break correction, once additional data is available. The appropriate treatment will depend on the nature of the impact and upon how much data and supplementary information is available.

FURTHER INFORMATION

For further information on this topic please contact Mark Zhang, Director of Time Series Analysis on (02) 6252 5132 or by email mark.zhang@abs.gov.au.

ENDNOTES

1. A version of this article was presented as a paper to an ABS consultative forum - the Economic Statistics User Group (ESUG) in April 2003.
2. It is still subject to debate whether the transitional level changes should be included in the trend estimates.

FURTHER READING

Australian Bureau of Statistics (2003). **A guide to interpreting time series - monitoring “trends”**, cat. no. 1349.0, ABS, Canberra

Australian Bureau of Statistics (2001). **Information Paper: Introductory Course on Time Series Analysis**, cat. no. 1346.0.55.001, ABS, Canberra

Shiskin, J., Young, A. H. And Musgrave, J.C. (1967). **The X11 Variant of the Census Method II Seasonal Adjustment Program**. Technical Paper 15, Bureau of the Census, U.S. Department of Commerce, Washington, D.C.

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